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Time-out! How psychological momentum builds up and breaks down in table tennis

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ABSTRACT

The current study examined the development of psychological momentum (PM) in table tennis and the effect of a time-out. Eighty table tennis players were exposed to an audiovisual scenario, in which they either came back from 1–7 to 7–7 in an all-decisive game (positive momentum), or in which the opponent came back from 7–1 to 7–7 (negative momentum). Furthermore, at the score of 7–7 a time-out was called. One group of participants received no specific instructions during the time-out, whereas the other group received task (mastery-approach – MAp) instructions. Overall, PM perceptions increased for participants in the positive momentum condition, but decreased rapidly for participants in the negative momentum condition. In addition, the time-out led to a loss of PM in the positive momentum condition, but to a recovery of PM in the negative momentum condition. The instructions during the time-out did not make a significant difference. Together, these results suggest that scoring patterns in a table tennis game significantly affect the PM of players. Furthermore, a player or coach could benefit from calling a time-out in a negative momentum situation, as this provides an opportunity to psychologically recover.

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Achievement goals; psychological dynamics; racquet sports; sport psychology; streaks

Introduction

In table tennis, most rallies are short and points can be scored in a relatively brief period of time. This makes it a particularly exciting sports to play and to watch, because one of the players can suddenly get the *momentum* and turn the match. This momentum is often referred to by players, coaches, and commentators, which reflects its assumed importance in table tennis. Another important part of the game is a time-out, which may be called once by a player or coach during a match. Time-outs are mostly called to interrupt a sequence of losing points (i.e., during negative momentum), because players and coaches believe that a time-out may influence the momentum in their favour (Xiao, 2015). In sport psychology, the term momentum is used to describe a player's impetus toward a desired outcome (positive momentum) or away from that outcome (negative momentum). Researchers often use the term *psychological momentum* (PM) to denote the psychological and behavioural changes that players undergo while experiencing such an impetus (e.g., Den Hartigh, Gernigon, Van Yperen, Marin, & Van Geert, 2014; Gernigon, Briki, & Eykens, 2010; Vallerand, Colavecchio, & Pelletier, 1988). During positive PM a player typically enters a more positive psychological state (e.g., increases in confidence, motivation, optimism), exerts more efforts and moves more efficiently, whereas the opposite would occur during negative PM (e.g., Adler, 1981; Den Hartigh et al., 2014; Perreault, Vallerand, Montgomery, & Provencher, 1998; Taylor & Demick, 1994). In accordance with the assumed importance of momentum and time-outs in table tennis, we conducted an empirical study to examine (a) how PM builds up in table tennis players, and (b) how a time-out breaks the PM of table tennis players.

In recent years, multiple studies have examined PM in table tennis (Briki, Den Hartigh, Bakker, & Gernigon, 2012; Briki, Den Hartigh, Hauw, & Gernigon, 2012; Briki, Doron, Markman, Den Hartigh, & Gernigon, 2014; Gernigon et al., 2010). In the first study of this series, Gernigon et al. (2010) investigated changes in psychological factors (self-confidence and competitive anxiety) while participants were exposed to a table tennis video (Study 1). One of the players in this video took a lead of 5–0, after which the opponent won point-after-point until he was 10–5 ahead. In one session, participants imagined being the player who came back from behind (positive momentum scenario), and in another session he imagined himself being the other player (negative momentum scenario). The authors found that confidence increased and anxiety decreased during positive momentum, whereas the opposite occurred during negative momentum. Moreover, in contrast to the positive momentum scenario, anxiety changed rapidly at the start of the negative momentum scenario, based on which the authors concluded that negative PM is triggered more easily than positive PM.

Following the article by Gernigon et al. (2010), quantitative and qualitative PM studies were conducted using videos of table tennis players' own matches. They replicated the finding that different psychological factors, including self-confidence and anxiety, change in positive and negative directions during positive and negative PM, respectively (Briki, Den Hartigh, Bakker, et al., 2012; Briki, Den Hartigh, Hauw, et al., 2012). More recently, Briki, Doron, et al. (2014) carried out an experimental study in which they suggested that PM can also be broken. The authors asked participants with table tennis experience to imagine they were playing a table tennis game. Participants were then

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exposed to an audiovisual scenario in which they (imagined they) were either lagging behind with 0–7 and came back to 7–7 (positive momentum scenario) or the other way around (negative momentum scenario). In one condition there was a power cut at the score of 7–7 that interrupted the game, whereas in the other condition there was not. In the positive momentum scenario, participants reported *less* PM after they had a power cut, compared to those who were not interrupted. In the negative momentum scenario, participants experienced *more* PM when they had a power cut, compared to those who did not. Although a power cut is a kind of interruption that is beyond the control of the players, the fact that it had an effect on PM makes it likely that calling a time-out—often a deliberate initiative of a player or coach—also has an impact. In other words, a time-out may give players with negative PM time to recover, whereas it may also take away some positive PM for players who are on a roll (Adler, 1981).

In this experimental study, we built upon the studies described above and aimed to answer the following research question: How does PM develop in table tennis players, and what is the effect of a time-out on players' PM? In line with previous PM research, our first hypothesis was that PM perceptions increase when players successively win points in a game, and decrease when they successively lose points. Our second hypothesis was that negative PM is triggered easily, whereas positive PM is not (Gernigon et al., 2010). Our third hypothesis was that a time-out has an impact on table tennis players' PM: A time-out following a sequence of winning points would decrease PM perceptions, whereas a time-out following a sequence of losing points would increase PM perceptions (cf. Briki, Doron et al., 2014). Finally, in table tennis it is considered important to use the time-out effectively (Xiao, 2015). This does not only pertain to the moment at which a time-out is called (e.g., when having negative PM), but also to the time spent during the time-out. In sports, a well-established belief is that players should focus on their task rather than the outcome. In other words, a mastery-approach (MAp) focus, meaning that players focus on performing their tasks well or improving on their tasks (Elliot & McGregor, 2001; Van Yperen, 2003), would promote performance as well as self-regulation, the maintenance of efforts, and the immersion in the task (Van Yperen, Blaga, & Postmes, 2014, 2015). Related to this, qualitative PM research suggested that table tennis players use MAp goals to maintain positive PM or overcome negative PM (Briki, Den Hartigh, Hauw, et al., 2012). Apart from testing our three hypotheses, we therefore also explored whether MAp instructions during the time-out help players to maintain positive PM after a sequence of winning points, and to better recover after a sequence of losing points.

Method

Design

Participants were randomly assigned to a positive momentum condition (N = 40) or a negative momentum condition (N = 40). Half of the participants in the positive momentum condition (N = 20) and in the negative momentum condition (N = 20) received MAp instructions during the time-out. The protocol of this study was approved by the ethical committee of the Department of Psychology, University of Groningen. The participants provided active consent before the start of the study, and they were assured that their contributions would be treated confidentially.

Participants

Our sample consisted of 80 table tennis players (70 male, 10 female; M_{age} = 33.81, SD = 15.33), recruited from different clubs in The Netherlands. This sample was representative for the population of Dutch table tennis players who engage in competition. The participants played at national or regional level, and on average had 12.93 years of experience with playing competitive matches (SD = 10.94).

Test protocol and procedure

The study took place at table tennis clubs, where we built the research setup in a quiet room. This research setup included a laptop, a headphone, and instructions and questionnaires on paper. When participants entered the research room they signed the informed consent form. Then, they read the instructions and were asked to vividly imagine themselves in a realistic, high-stake situation, in which PM is most likely to develop (e.g., Briki, Doron, et al., 2014; Gernigon et al., 2010; Markman & Guenther, 2007). For all participants, the point of departure was a situation in which they played the all-decisive (fifth) game in a championship match. "*You are ranked 2nd with your team in the competition and on the last day you play against your direct rival, the number 1. Both your team and the opponent want to win the championship. Your team needs to win in order to become the champion, whereas for the opponent a draw would suffice. When the last match starts, your team is 5–4 ahead in matches, and you are going to play the last match. If you win, your team will be the champion, if you lose, the opponent team is the champion. The score becomes 2–2 in games and you are now 7–1 ahead* [or 1–7 behind] *in the all-decisive game*". Having read this scenario, participants filled out a brief PM questionnaire.

Subsequently, participants put on the headphone attached to the laptop, to watch and listen to one of the audiovisual scenarios that we created, which resembled those used by Briki et al. (2014). The score of the participant and his or her opponent were displayed in large rectangles on the laptop screen, and were updated after each rally. Participants heard the rallies and the clapping sounds following each rally through the headphones. In the positive momentum condition participants were 1–7 behind in the all-decisive game, but came back to 7–7; in the negative momentum condition the participants were leading by 7–1, but then lost point-by-point until it was 7–7. After each point (between 7–2 and 7–7), participants had 12 seconds to fill out the brief PM questionnaire (see Measures section).

When the score was 7–7, participants heard "time-out" through their headphone, and the following text appeared on the laptop screen: "A time-out has been called". Participants in the MAp condition were then exposed to the following text: "In this time-out you get the following instructions (imagine this vividly): Carry out your tactics as well as possible; keep moving;

keep your eye on the ball; play point-by-point". These latter instructions were constructed in consultation with high-level players and coaches, who indicated that these are general task instructions that are meaningful to players during time-outs. The other half of the participants did not receive specific instructions and read the text: "use this time-out in your own way (imagine this vividly)". Thirty seconds after the time-out was called, the following text appeared on the screen: "You and your opponent are walking back to the table to resume the match", followed by "please answer the four items again". Hence, after the time-out participants filled out the PM questionnaire one last time. Finally, all participants responded to one question to check whether they managed to imagine themselves in the match.

Measures

The PM questionnaire that participants repeatedly filled out consisted of four items. These items were selected and adapted from the PM questionnaire of Vallerand et al. (1988). This questionnaire has been successfully used in different kinds of settings, from research based on hypothetical PM scenarios (e.g., Eisler & Spink, 1998; Miller & Weinberg, 1991; Vallerand et al., 1988) to research in actual performance situations (e.g., Briki, Den Hartigh, Markman, Micallef, & Gernigon, 2013; Kerick, Iso-Ahola, & Hatfield, 2000; Perreault et al., 1998; Stanimirovic & Hanrahan, 2004). The four items we used were: At this moment in the match… "I feel self-confident"; "I am progressing toward the victory"; "I feel discouraged; and "I feel energetic". The order of the items was randomized for each measurement, and they were answered on a 7-point Likert-type scale (1 = *not at all*, 7 = *very much*). The outcome measure was the mean of the item scores, which represented the level of PM. We calculated Cronbach's alpha for each measurement moment (i.e., eight times), which ranged between .67 and .87 with an average of .76 across the eight measures. The final check-item was "To what extend were you able to imagine yourself in the match?" (1 = *Not at all*, 7 = *very much*).

Data analysis

First, we employed a 2 × 7 ANOVA (Momentum: Positive vs. Negative × Moment: From 7–1 to 7–7) with repeated measures on the last factor. In order to test whether PM increases across a sequence of winning points and decreases across a losing sequence (*hypothesis 1*), we conducted linear trend analyses over the different moments within the positive and negative momentum conditions (from 1–7 to 7–7 and 7–1 to 7–7). Then, using post-hoc (Bonferroni) comparisons, we tested potential significant differences between adjacent data points. In order to test whether negative PM is triggered easily whereas positive PM is not (*hypothesis 2*), we focused on the start of the momentum conditions.

To determine the effects of the time-out and the possible influence of MAp instructions, we employed a 2 × 2 × 2 ANOVA, with Momentum (Positive vs. Negative) and Instruction (MAp vs. No instruction) as between-subject factors, and Moment (Before time-out vs. After time-out) as within-subject factor. To test whether a time-out following a winning sequence decreased PM, whereas a time-out after a losing sequence increased PM (*hypothesis 3*), we first analysed the Momentum × Moment interaction effect. Then we analysed the differences in PM before and after the time-out within the positive- and negative momentum conditions. Finally, we explored whether these effects were moderated by the instructions participants received during the time-out—MAp instructions or no explicit instructions—, by analysing the Instruction × Moment interaction.

Results

First, we checked whether participants were well-able to imagine themselves in the table tennis scenarios, which was the case ($M = 5.48$, $SD = 1.09$). Figure 1 displays the PM development in the positive momentum condition (from 1–7 to 7–7) and in the negative momentum condition (from 7–1 to 7–7). In accordance with our first hypothesis, we found a significant interaction effect for Momentum × Moment ($F(6, 468) = 94.24$, $p < .001$, partial $\eta^2 = .55$). Trend analyses revealed a significant increasing linear trend for PM perceptions in the positive momentum condition ($F(1, 39) = 99.47$, $p < .001$, partial $\eta^2 = .72$) and a significant decreasing trend in the negative momentum condition ($F(1, 39) = 90.23$, $p < .001$, partial $\eta^2 = .70$). Looking at adjacent differences at the start of the positive and negative momentum conditions, the first significant difference occurred between moment 1 ($M = 4.28$, $SD = .17$) and moment 3 ($M = 5.13$, $SD = .14$) in the positive momentum condition ($p < .001$). On the other hand, in accordance with our second hypothesis, in the negative momentum condition there was already a significant difference between moment 1 ($M = 5.74$, $SD = .14$) and moment 2 ($M = 5.14$, $SD = .14$, $p < .001$).

Figure 2 shows the effects of the time-out in the positive and negative momentum conditions, for participants who received MAp instructions or no specific instructions. First,

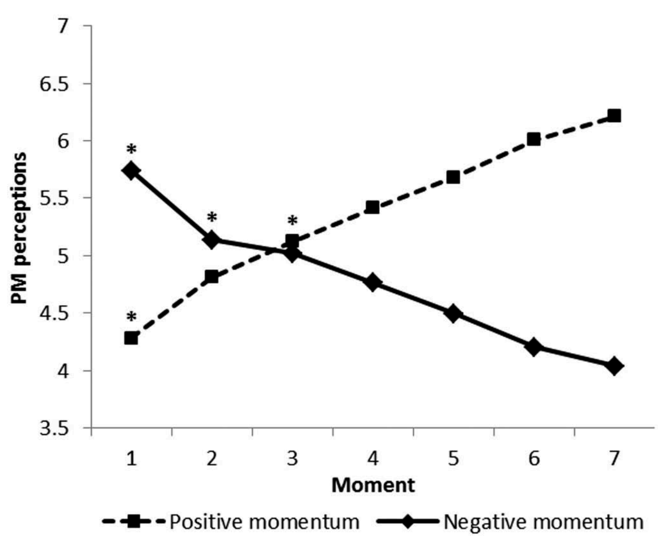

Figure 1. Development of PM perceptions in the positive momentum and negative momentum conditions. The asteriks indicate the first two moments between which there is a significant difference in the positive and negative momentum conditions. On the x-axis, the moments 1 to 7 correspond to the different scores (1–7 to 7–7 or 7–1 to 7–7).

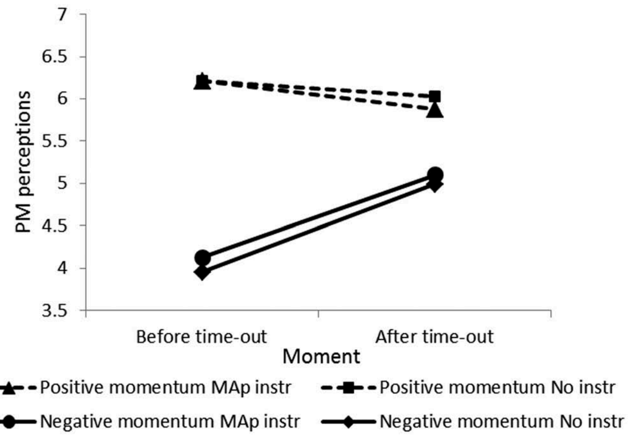

Figure 2. Participants' PM perceptions before and after the time-out, according to instruction (with MAp instructions or no explicit instructions).

we detected a significant main effect for Momentum ($F(1, 78) = 73.46$, $p < .001$, partial $\eta^2 = .49$). PM perceptions were higher in the positive momentum condition ($M = 6.08$, $SD = .13$) than in the negative condition ($M = 4.54$, $SD = .13$). There was also a significant interaction effect between Moment (i.e., before and after the time-out) and Momentum ($F(1, 76) = 34.63$, $p < .001$, partial $\eta^2 = .31$). In accordance with our third hypothesis, within conditions we found a main effect for Moment in the positive momentum condition ($F(1, 38) = 4.92$, $p = .03$, partial $\eta^2 = .12$) and in the negative momentum condition ($F(1, 38) = 31.16$, $p < .001$, partial $\eta^2 = .45$). In the positive momentum condition, PM perceptions were *higher* before the time-out ($M = 6.21$, $SD = .86$) than after the time-out ($M = 5.95$, $SD = .96$), whereas in the negative momentum condition PM perceptions were *lower* before the time-out ($M = 4.04$, $SD = .1.06$) than after the time-out ($M = 5.04$, $SD = .84$). With regard to the instructions, we found no significant Instruction × Moment interaction effect in the positive momentum condition ($p = .53$) and negative momentum condition ($p = .86$).

Discussion

Players, coaches, and researchers consider that momentum plays an important role in table tennis (e.g., Gernigon et al., 2010; Xiao, 2015). Insights into how PM builds up and breaks down in table tennis is therefore of high relevance to both research and practice. The current research aimed to replicate and extend previous research on PM in table tennis by experimentally investigating (a) the development of positive and negative PM in an important table tennis game, and (b) the effects of a time-out to possibly break players' PM in the game.

First we found that players' PM—confidence, energy, optimism, and progress—increased when coming back from 1–7 to 7–7, and decreased in the opposite scenario, when losing the 7–1 advantage. These results are in line with a defining characteristic of PM, namely that positive PM develops when moving toward a desired outcome (winning the game in this case), and negative PM develops when moving away from this outcome (e.g., Adler, 1981; Gernigon et al., 2010; Markman & Guenther, 2007; Vallerand et al., 1988). An additional interesting finding was the clear difference in PM perceptions between the positive and negative momentum condition at the score of 7–7 (see Figure 1, Moment 7). Although the score was objectively neutral at that moment (i.e., 7–7), the preceding sequence of winning or losing points made a considerable difference in the PM experience of the players. This result fits with the idea that PM is "history-dependent", as demonstrated in a previous table tennis study (Gernigon et al., 2010) and in other sports (Briki et al., 2013; Den Hartigh et al., 2014; Den Hartigh, Van Geert, Van Yperen, Cox, & Gernigon, 2016). The score at a given moment may therefore not be the most relevant factor generating a player's PM experience, it is mainly *the path leading to* the score.

The current study also replicates another pattern that has been found in table tennis research. In accordance with Gernigon et al. (2010), we found that negative PM developed rapidly at the start of the negative momentum scenario, whereas positive PM did not develop rapidly at the start of the positive momentum scenario. This asymmetry between positive and negative PM thus seems a robust pattern in table tennis, which has also been detected in other sports such as rowing (Den Hartigh et al., 2014) and cycling (Briki et al., 2013).

Focusing on PM before and after a time-out, we found the anticipated opposite effects after a winning sequence versus a losing sequence. A time-out following a sequence of winning points led to a decrease in players' PM perceptions, whereas a time-out after a sequence of losing points led to an increase. These findings correspond to the idea that breaking a player's momentum sequence has an impact on his or her PM experience (Adler, 1981; Briki, Doron, et al., 2014). It also suggests that table tennis players can effectively use a time-out to overcome their own negative PM and to decrease their opponents' positive PM. However, based on the current study we cannot provide concrete recommendations for how to effectively use the time-out, given that providing MAp instructions did not moderate the effect of a time-out. This may seem surprising, because researchers have consistently postulated that MAp goals facilitate performance and self-regulation (Van Yperen et al., 2014, 2015), and can help overcoming negative PM and maintaining positive PM (Briki, Den Hartigh, Hauw, et al., 2012). There could be two explanations for the absence of an effect of MAp instructions. First, in the condition without MAp instructions participants were told to "use the time-out in your own way". It could be that participants also imagined the use of MAp goals in this condition, because they were used to doing so. Alternatively, the MAp instructions may have been too general to bring about a difference compared to the condition in which no explicit instructions were stated.

Our results thus show that a time-out had an impact on PM, regardless of the instructions. Explanations for this can be drawn from two different theoretical perspectives. First, Markman and Guenther (2007) suggested a parallel between PM and the concept of momentum in physics. Based on their theory, PM would exhibit an inertial property, entailing that PM keeps moving in its current direction until it is interrupted (see also Briki, Doron, et al., 2014). This may explain why the time-out caused the upward movement to stop after a sequence of winning points, and the downward move to stop after a sequence of losing points. Interestingly in this regard is that the movement of PM even changed direction, which suggests that a time-out exerts a strong opposite force on PM. A second theoretical explanation is based on the concept of PM as a dynamical system (see Briki, Den Hartigh, Markman, & Gernigon, 2014; Briki et al., 2013; Den Hartigh et al., 2014, 2016; Gernigon et al., 2010). In general, a dynamical system can be defined as a set of moving, interacting elements from which specific (equilibrium) states emerge. In this light, the time-out would provide the dynamical system, PM in this case, time to recover to its "natural" equilibrium state that may be neutral (i.e., not positive PM nor negative PM). Therefore, a time-out after a sequence of winning points would decrease the level of PM, whereas a time-out after a sequence of losing points would increase the level of PM.

Limitations and future directions

For the sake of experimental control, we employed a research design with audiovisual scenarios. For future research it would be interesting to provide deeper insights into table tennis players' actual performances. Recent research outside table tennis has already demonstrated different patterns of movement coordination and effort exertion during positive and negative PM (for two studies in rowing, see Den Hartigh et al., 2014, 2016). Furthermore, studies in basketball have shown that calling a time-out has an actual effect on the scoring pattern, and weakens the opponent's performance (see Mace, Lalli, Shea, & Nevin, 1992; Roane, Kelley, Trosclair, & Hauer, 2004). To take a new step, we believe it would be particularly interesting to focus on table tennis players' behaviours, such as their movement fluency, in order to see how this is affected by positive and negative momentum, as well as time-outs. Another limitation of our study is that we do not know what the players imagined exactly during the time-out. Therefore, it would be interesting to conduct more studies on effectively using time-outs. One possibility could be to conduct qualitative interviews, in which the researcher investigates what players (and their coaches) did when they used the time-out wisely and when it worked in their favour.

Conclusion and practical recommendations

In the current study, we provided new insights into how PM builds up and can be broken by using a time-out. We revealed that, first, the winning sequence generated an increasing trend in the players PM experience, whereas the losing sequence generated a rapid negative PM development. Moreover, when the score was 7–7, the level of PM was considerably higher for players with a sequence of winning points. These results suggest that the scoring pattern in a table tennis match significantly affects "the mind" of the table tennis player, even if the score is objectively neutral. In order to better deal with momentum fluctuations in a match, players may work on improving their psychological skills. These may include strategies of mental control (e.g., imagery) and goal focus (e.g., goal setting) to stabilize states of positive PM and to delay or even cancel the occurrence of negative PM (Gernigon et al., 2010). Ideally, coaches should equip themselves with the ability to deliver psychological skills training, as initial evidence suggests that coach-delivered interventions have the strongest positive effects (Brown & Fletcher, 2017).

As we demonstrated, a specific strategy that can be applied during a match is calling a time-out. We showed that, at a score of 7–7, a time-out led to a decrease in PM after a winning sequence and an increase after a losing sequence, regardless of the instructions provided. It thus seems wise for a player or coach to call a time-out in a negative momentum situation. In accordance with Xiao's (2015) advice to pick the right moment for a time-out, it is important to recognize the negative momentum situation. Negative PM develops when a player perceives he or she moves away from a desired outcome (e.g., winning the game), which can occur in different kinds of matches and at different scores. However, PM develops more easily when (a) the match is important (Markman & Guenther, 2007), and (b) the stage of the match is critical (Miller & Weinberg, 1991). This means that negative PM is likely to develop during a sequence of losing points, but this sequence has a stronger impact when it occurs at a more critical point in the game (e.g., from 7–7 to 7–10), than at the start of the game (e.g., from 1–1 to 1–4). Thus, calling a time out seems a useful strategy to psychologically recover from a losing sequence, in particular when it occurs at a critical phase of the game or match.

Disclosure statement

No potential conflict of interest was reported by the authors.

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